Asthma Guidelines
An Assessment of Physician Understanding and Practice

KEVIN C. DOERSCHUG, MICHAEL W. PETERSON, CHARLES S. DAYTON, and JOEL N. KLINE

Division of Pulmonary, Critical Care, and Occupational Medicine, University of Iowa, Iowa City, Iowa

In 1997 the NHLBI updated guidelines for the diagnosis and management of asthma. We hypothesized that not all components of the updated guidelines are well understood by the physicians who care for asthmatics. To develop appropriate educational interventions that address areas of physician misunderstanding, it is important to identify these components. Based upon NHLBI guidelines, we developed a multiple-choice test of asthma knowledge that was distributed to physicians at the University of Iowa; 108 physicians completed the test, including 20 asthma specialists, 11 asthma specialty fellows, 11 General Medicine faculty, five Family Medicine faculty, 51 Internal Medicine residents, and five Family Medicine residents. The mean correct total score for all physicians was 60 ± 2% (mean ± SEM). Asthma specialists scored higher in total score and in pharmacology and prevention. However, no group performed well on estimating disease severity. We further identified deficits in the use of spirometry and anti-inflammatory agents in caring for asthmatic patients. Thus, deficits exist in physician understanding and implementation of the NHLBI guidelines for the diagnosis and management of asthma. By identifying specific areas of misunderstanding, we can design better educational interventions. Clearly, educational programs should emphasize new models for estimating chronic disease severity. Doerschug KC, Peterson MW, Dayton CS, Kline JN. Asthma guidelines: an assessment of physician understanding and practice. AM J RESPIR CRIT CARE MED 1999;159:1735–1741.

Asthma is an inflammatory disease of the airways that affects more than 15 million people in the United States (1). To improve asthma management, the National Asthma Education and Prevention Program (NAEPP) Expert Panel sponsored by the National Heart, Lung, and Blood Institute (NHLBI), developed the Guidelines for the Diagnosis and Management of Asthma in 1991 (2). This report focused on the role of patient education and the use of objective measures of lung function, including home peak-flow monitoring. It also recognized the role of inflammation in the pathogenesis of asthma and recommended anti-inflammatory medications for patients with moderate and severe asthma. In 1997, the NHLBI updated their recommendations in the Expert Panel Report 2: Guidelines for the Diagnosis and Management of Asthma (EPR-2) (3). This report reinforced the previous recommendations and further emphasized the role of airway inflammation in the pathogenesis of asthma. EPR-2 also modified the disease severity classification system to better identify patients who were likely to benefit from anti-inflammatory medications. Focusing on symptom frequency (with attention to nocturnal symptoms) and variation in airflow obstruction, this system classifies patients into mild intermittent, mild persistent, moderate persistent, or severe persistent asthma categories. Anti-inflammatory medications are recommended for all patients with persistent asthma.

Despite the existence of guidelines for the diagnosis and management of asthma for more than a decade (including British guidelines), there is a wide range of practice patterns in asthma. Deviations from published guidelines of the care of asthmatics have been described in pediatric (4), inner-city (5), and private HMO (6, 7) patient populations. Although asthma specialists (pulmonologists and allergists) are more likely to provide care that is compliant with the Guidelines than are generalists (4, 6, 7), it is not clear whether this difference reflects a different level of understanding the Guidelines between these groups. Patient factors are also important in determining compliance with practice guidelines, and low patient income and level of education correlate with disease management which is noncompliant with the Guidelines (5). However, even patients with higher socio-economic status who receive care from asthma specialists are not always treated in accordance with the Guidelines (6).

A clear physician understanding of the guidelines is the first and essential step in applying the guidelines to patient care. On the basis of these studies and on observations in our medical community, we hypothesized that poor physician understanding of the guidelines may play an important role in compliance with the recommendations. We undertook the current study to test physician understanding of the guidelines. Because understanding the guidelines is only the first step in applying their principles to patient care, we also evaluated asthma patient care. Using institutional databases, we evaluated how often patients had spirometry measurements and we evaluated how often anti-inflammatory drugs were used to treat asthmatics.

(*Received in original form September 11, 1998 and in revised form November 24, 1998*)

Supported by grants from the American Lung Association.

Correspondence and requests for reprints should be addressed to Joel N. Kline, M.D., C33GH, UIHC, Iowa City, IA 52242.

Am J Respir Crit Care Med Vol 159. pp 1735–1741, 1999
Internet address: www.atsjournals.org

METHODS

Evaluating Physician Knowledge

To evaluate physician understanding of the guidelines, we developed a 31-question, multiple-choice test of asthma knowledge using EPR-2 as the source of content and validity. Questions were based on EPR-2 recommendations, and three of the authors (K.C.D., M.W.P., and J.N.K.) reviewed the questions and answers prior to giving the test. In addition, four pulmonologists not involved in the subsequent study took a version of the test that included many more questions than were included on the test as ultimately configured. Their responses were reviewed and the three participating authors evaluated questions with incorrect answers for clarity and content before supplying the questionnaire to participating study physicians. Questions found to be confusing or incorrect were clarified or removed. This process continued in the first phase of testing, in which the study subjects were pulmonary faculty and fellows. The questions that were answered with a substantial range of incorrect answers were reevaluated by the investigators, and an additional four questions were removed from subsequent versions of the test and not counted towards the score. Participating physicians were instructed to answer according to their understanding of the guidelines rather than their practice patterns. The test was distributed to physicians at our institution by personal contact at teaching conferences, by mail, and by department heads. This protocol was approved by the University of Iowa institutional review board for human studies (Committee A), which determined that it was not necessary to obtain written consent from the subjects.

The test was distributed to faculty members in Family Medicine (n = 16), General Internal Medicine (n = 12), and asthma specialties (adult Pulmonary Medicine and adult Allergy Immunology, n = 23). Internal Medicine residents (n = 102), Family Medicine residents (n = 26), and asthma subspecialty fellows (n = 12) also participated.

The test questions were divided into core competencies of disease assessment, diagnosis, patient education, pathophysiology, pharmacology, prevention, disease severity, and therapeutic modalities; the questions were arranged in random order when presented to the physicians. Each question was designed to have a single correct answer. A total score and a score for each of seven core competencies was calculated for each participant.

Scores were grouped according to the level of training (resident, general practitioner, fellow, and specialist) as well as by the specialty of certified practitioners (Family Medicine, Internal Medicine, and asthma specialists). Mean scores for each subgroup were reported and compared using one-way analysis of variance with Tukey-B post-hoc testing (significance set at $p < 0.05$) (8).

Evaluating Physician Behavior

In conjunction with these evaluations, we identified all patients with asthma receiving care at our institution in 1996 and 1997 using ICD-9 codes (49300, 49301, 49310, 49390). After identifying 3,384 adult patients, we randomly selected 206 patients to evaluate. All of these 206 patients had been followed for at least 2 yr at our institution. We used two separate databases to evaluate management decisions. With the first, we determined whether the patients had undergone pulmonary function testing within 2 yr. This database captures only pulmonary function testing completed in the PFT Laboratory. Some of our clinics perform spirometry using free-standing units; however, only the equipment in the PFT laboratory is quality controlled to meet ATS standards (9). Because the guidelines recommend spirometry using equipment and facilities meeting ATS standards, we include only spirometry performed in a laboratory meeting those standards. In the second database, we determined which prescription drugs they were receiving. We categorized the patients as receiving a treatment if they received the drug at any time during the 2 yr. These data on spirometry and therapy were used to assess whether patients with asthma received care consistent with the NHLBI Guidelines (3).

RESULTS

Physician Knowledge

A total of 108 physicians out of 191 at our institution completed the test. This included 20 of 23 asthma specialists (87%), 11 of 12 asthma specialty fellows (92%), 11 of 12 general internists (92%), five of 16 family physicians (31%), 55 of 102 Internal Medicine residents (54%), and five of 26 Family Medicine residents (19%). All scores are listed by category of question and physician group in Table 1. The mean score for all physicians who took the test was 60 ± 2% (mean ± SEM). Physicians performed best in questions regarding the diagnosis of asthma (77 ± 8%); but they performed lowest in questions regarding the estimation of disease severity (46 ± 2%).

Asthma specialty faculty scored significantly higher overall (78 ± 3%) than primary care faculty (65 ± 3%), but they did not score significantly higher than asthma specialty fellows (69 ± 2%). Residents scored lower than physicians at all other levels of training (Figure 1). There was a significant improvement in total score throughout residency training, with interns scoring significantly lower than junior or senior residents (data not shown).

Among faculty members, asthma specialists scored higher than general internists and family physicians in the categories of pharmacology, prevention, and total score (Figure 2). Both asthma specialists and general internists scored significantly higher than Family Practitioners in questions regarding the diagnosis of asthma.

TABLE 1

RESULTS OF QUESTIONNAIRE ON ASTHMA KNOWLEDGE

	Total	Assessment	Diagnose	Education	Pathology	Pharmacology	Prevention	Severity	Therapy
Number of questions	31	3	3	1	3	6	2	6	7
Mean score									
Total, n = 103	0.60	0.64	0.77	0.37	0.70	0.63	0.54	0.46	0.62
Family Medicine									
Residents, n = 4	0.54	0.42	0.67	0	0.75	0.58	0.38	0.50	0.50
Faculty, n = 8	0.63	0.67	0.63	0.13	0.71	0.69	0.56	0.56	0.70
Internal Medicine									
Residents, n = 51	0.51	0.58	0.69	0.27	0.59	0.51	0.45	0.35	0.55
PGY-1 n = 18	0.45	0.48	0.61	0.39	0.57	0.42	0.36	0.27	0.54
PGY-2 n = 15	0.50	0.58	0.64	0.13	0.56	0.52	0.53	0.41	0.52
PGY-3 n = 18	0.57	0.69	0.80	0.28	0.65	0.60	0.47	0.39	0.58
Faculty, n = 11	0.67	0.64	0.88	0.18	0.82	0.68	0.64	0.55	0.68
Asthma Specialists									
Fellows, n = 11	0.69	0.76	0.97	0.89	0.79	0.76	0.41	0.55	0.61
Faculty, n = 18	0.78	0.75	0.91	0.49	0.83	0.86	0.83	0.63	0.76

Figure 1. Overall performance by level of training. Asthma specialist faculty scored significantly better on the asthma knowledge test than did primary care faculty or residents. Medicine residents scored significantly lower on the asthma knowledge test than any other group of physicians (*$p < 0.05$).

All physician groups, regardless of training, scored lowest in questions regarding the classification of chronic disease severity. Overall, physicians answered less than 50% of these questions correctly (Figure 3). Although residents scored significantly lower than physicians in all other levels of training, there were no significant differences between primary care faculty (55 ± 6%), asthma specialty fellows (55 ± 7%), and asthma specialty faculty (63 ± 6%) in the ability to estimate chronic disease severity using the NAEP 2 Guidelines. The majority of errors led to an underestimation of disease severity.

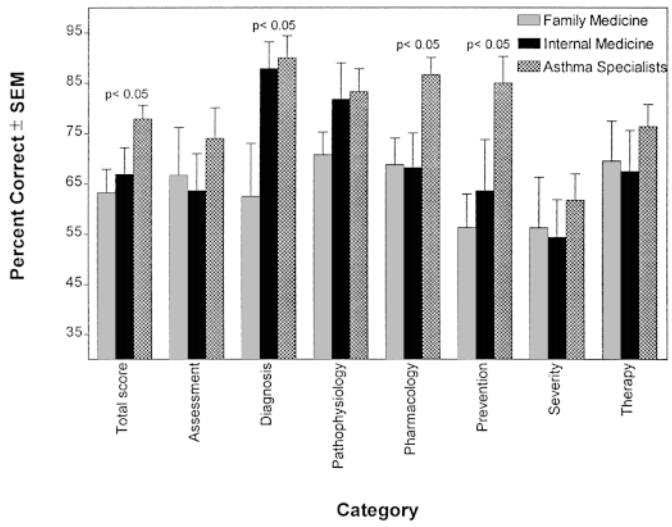

Figure 2. Comparison of performance by faculty members in different specialties. Asthma specialists scored significantly higher than did general internists or family physicians in total score and in the subcategories of asthma diagnosis, pharmacology, and prevention. Asthma specialists scored significantly higher than did family physicians in the diagnosis subcategory.

Physician Behavior

Of the 206 patients we identified, 85 (41%) were male and 121 (59%) were female. The mean age was 39 yr (range, 17 to 88 yr). These demographics are not significantly different from the sex and age distribution of all identified asthma patients in our hospital. Contrary to the recommendations of the EPR-2, spirometry had been performed on only 94 (46%) of these patients within the previous 2 yr. To determine whether the patients were receiving appropriate "step" therapy, we performed two analyses. First, we identified 35 patients with a $FEV_1 < 60\%$ predicted, using the normal values of Morris and colleagues (10), and we reviewed their treatment program. Based on the low FEV_1, each of these patients qualified as having severe persistent disease according to the NAEP 2 Guidelines. However, six (17%) of these patients were receiving inhaled beta-agonists only. Second, we identified 31 patients receiving either no medications or beta-agonists only. We were able to review 24 of these patient charts, and on the basis of this review, five (21%) of these patients met criteria for moderate or severe persistent disease as defined by the NAEP 2. Thus, in both analyses, approximately one in five patients were receiving inadequate "step" therapy.

DISCUSSION

Asthma continues to be an important public health problem in the United States. Because of the number of asthmatic patients and their cumulative impact on healthcare costs and potential productivity, the National Institutes of Health impaneled two expert groups in the 1990s to develop guidelines for diagnosing and managing asthma (2, 3). Their last report, published in 1997 (3), suggested a new staging system for chronic asthma, developed treatment paradigms based on the staging system, emphasized the importance of objective disease monitoring, and highlighted the role for anti-inflammatory drugs in

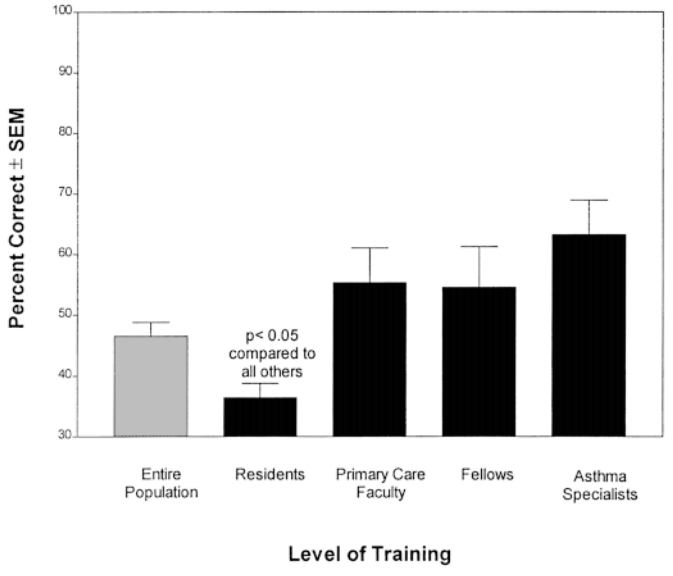

Figure 3. Performance of all physicians in the estimation of disease severity. No group of physicians performed very well in the questions that covered estimation of asthma severity. The mean score for all physicians was 46 ± 2.3%. Although residents scored significantly lower than physicians in all other levels of training (36 ± 2.4%), there were no differences between primary care faculty, asthma specialty fellows, and asthma specialty faculty.

asthma management. The panel felt strongly that implementing these guidelines for most asthmatic patients would improve disease control and outcome.

Introducing new clinical guidelines into clinical practice requires altering physician behavior. Altering physician behavior is a complex process. Physicians must first be aware of new scientific developments or evidence-based practice guidelines. They must then incorporate these changes into their clinical practice. Continuing medical education has traditionally assumed the role for making physicians aware of new guidelines and scientific findings in medicine. To better design continuing medical educational interventions, it is important to understand the educational needs of the physician audience. In order to better understand physician educational needs in asthma, we evaluated physicians' understanding of the current guidelines for the diagnosis and management of asthma using a varied group of physicians at an academic medical center.

In our study we found that training and subspecialization influence understanding the guidelines. Residents in medicine had the lowest test scores; however, the test scores did improve with duration of training. These data suggest that residents are appropriately learning asthma management during their training. Although this conclusion may appear self-evident, residents do not always improve their skills with training (11). Our second finding was that subspecialists caring for adult asthmatic patients (pulmonologists and allergists) had the best overall understanding of the guidelines. This result probably reflects increased exposure to the guidelines in forums such as publications, professional meetings, and other forms of continuing education.

Despite the positive impact of training on asthma understanding, all physician groups had a poor understanding of the new chronic disease severity staging system. Even asthma subspecialty physicians correctly staged only 63% of the patients, and overall physicians appropriately staged chronic disease severity in 46%. This is especially a problem in clinical care because treatment recommendations are tied closely to chronic disease severity. Most errors among our physicians in determining disease severity underestimated the severity. This underestimate would result in undertreating most of the patients. The most common errors were not recognizing daily symptoms, even if mild, as at least moderate persistent asthma; failure to recognize daily β_2-agonists as poorly controlled asthma; and failure to recognize weekly nocturnal symptoms as moderate persistent disease.

Our findings related to physician knowledge were relevant to patient care issues. Our data analyzing physician behavior in asthma treatment correlate with the objective measurements of asthma guideline understanding as measured by the questionnaire. Although most asthmatic patients seen at our institution were appropriately treated with anti-inflammatory medications, a substantial minority of patients was undertreated based on their pulmonary function. Although we have no direct evidence for this, it is tempting to speculate that this behavior reflects the weakness in severity measurement that we identified in the test. Furthermore, our physician group failed to utilize objective disease monitoring as often as suggested by the guidelines. These data further support the need for focused CME related to the asthma guidelines.

Our study included only physicians at a midwestern academic medical center. However, we do not feel the results are unique to our institution. In fact, these results may underestimate the knowledge gap related to the asthma guidelines in a broader physician population. Our results are supported by Legorreta and colleagues (6) who reported that in a large HMO experience, only 67% of asthmatic patients received a steroid inhaler (less than half of these patients used the inhaled steroids on a daily basis). In addition, they reported that 11% of their asthmatic patients used an inhaled β_2-agonist more than eight times a day. Even among patients seeing an asthma specialist, 80% of the patients received inhaled steroids; however, nearly 14% were using their inhaled β_2-agonist more than eight times a day. Although some of this may be due to patient noncompliance, this overuse of rescue medication among patients followed by asthma specialists also suggests that even this group of physicians may have an incomplete understanding of the revised asthma disease severity definitions and treatment recommendations.

Questions may be raised regarding the sampling error in a questionnaire-based study such as this one. It is difficult to determine the reproducibility of our questionnaire because it is not meant to compare "expert" opinion with the guidelines. Rather, it tests understanding of the guidelines. (Indeed, participants were instructed to answer questions as they understood the Guidelines rather than their usual practice patterns.) Thus, physicians may "learn" in the process of taking the test and consequently alter the subsequent answers. Repeated testing is not appropriate for the assessment of this type of questionnaire. That notwithstanding, as we describe in METHODS, the questionnaire was "honed down" from an original 40 to 31 questions to improve the quality and "validity" of the questionnaire. Thus, analysis of the questionnaire by experts in asthma management allowed us to eliminate unclear or misleading questions. In addition, we do not think that selection bias changes our results. Obviously, anything short of complete compliance potentially introduces bias. However, almost all the available asthma faculty (18 of 23) and fellows (11 of 12) participated in the study. Second, resident physicians (51 of 102 total) for this study were those attending a regularly scheduled teaching conference. They were unaware of the goals of the questionnaire prior to the conference, and none of the participants refused to answer questions or to complete the questionnaire.

The EPR-2 is now considered to be the "gold standard" for asthma diagnosis and management. Although guidelines are not universally accepted (for example, recommendations for the use of peak flow monitoring are controversial) (12, 13), it seems appropriate that physicians accept or reject guidelines based on evidence and not on ignorance. On the basis of the results of our study, we can make the following recommendations:

1. All physician groups can benefit from continuing medical education focused on the asthma guidelines.
2. Educational interventions can and should be tailored to different physician groups based on their training background.
3. All physicians could benefit from further training in using the new chronic disease severity definitions and applying treatment paradigms based on disease activity.

On the basis of previous studies of CME effectiveness, the educational programs should include enabling (facilitating practical application of change into the practice setting) and reinforcing components (14). The most effective educational programs will also incorporate the educational process into the physician work flow (15, 16).

References

1. Centers for Disease Control. 1995. Asthma—United States, 1989–1992. *MMWR CDC Surveill. Summ.* 43:952–955.
2. National Asthma Education and Prevention Program. 1991. Expert Panel Report: Guidelines for the Diagnosis and Management of Asthma. National Institutes of Health, Bethesda, MD.

3. National Heart, Lung, and Blood Institute. 1997. Expert Panel Report 2: Guidelines for the Diagnosis and Management of Asthma. National Institutes of Health, Bethesda, MD.
4. Crain, E. F., K. B. Weiss, and M. J. Fagan. 1995. Pediatric asthma care in U.S. emergency departments. Current practice in the context of the National Institutes of Health guidelines. *Arch. Pediatr. Adolesc. Med.* 149:893–901.
5. Lang, D. M., M. S. Sherman, and M. Polansky. 1997. Guidelines and realities of asthma management: the Philadelphia story. *Arch. Intern. Med.* 157:1193–1200.
6. Legorreta, A. P., J. Christian-Herman, R. D. O'Connor, M. M. Hasan, R. Evans, and K. M. Leung. 1998. Compliance with national asthma management guidelines and specialty care: a health maintenance organization experience. *Arch. Intern. Med.* 158:457–464.
7. Vollmer, W. M., M. O'Hollaren, K. M. Ettinger, T. Stibolt, J. Wilkins, A. S. Buist, K. L. Linton, and M. L. Osborne. 1997. Specialty differences in the management of asthma: a cross-sectional assessment of allergists' patients and generalists' patients in a large HMO. *Arch. Intern. Med.* 157:1201–1208.
8. Rosner, B. 1980. Fundamentals of Biostatistics, 3rd ed. PWS-Kent, Boston.
9. American Thoracic Society. 1995. Standardization of spirometry: 1994 update. *Am. J. Respir. Crit. Care Med.* 152:1107–1136.
10. Morris, J. F., A. Koski, and L. C. Johnson. 1971. Spirometric standards for healthy nonsmoking adults. *Am. Rev. Respir. Dis.* 103:57–67.
11. Day, R. P., M. G. Hewson, P. Kindy, Jr., and J. Van Kirk. 1993. Evaluation of resident performance in an outpatient internal medicine clinic using standardized patients. *J. Gen. Intern. Med.* 8:193–198.
12. Gibson, P. 1993. Asthma guidelines and evidence-based medicine. *Lancet* 342:1305.
13. Naylor, C. D. 1995. Grey zones of clinical practice: some limits to evidence-based medicine. *Lancet* 345:840–842.
14. Davis, D. A., M. A. Thomson, A. D. Oxman, and R. B. Haynes. 1992. Evidence for the effectiveness of CME: a review of 50 randomized controlled trials. *J.A.M.A.* 268:1111–1117.
15. Manning, P. R., and L. DeBakey. 1992. Lifelong learning tailored to individual clinical practice. *J.A.M.A.* 268:1135–1136.
16. Brown, J., A. Collins, and P. Duguid. 1989. Situated cognition and the culture of learning. *Educ. Res.* (Jan–Feb):32–42.

APPENDIX

Asthma Knowledge Questionnaire

The following questions should be answered according to the Guidelines for the Diagnosis and Management of Asthma; Expert Report 2. There is one *best* answer for each question.

Please identify your level of training:

R1 ☐ R2 ☐ R3 ☐ Fellow ☐ Staff ☐

1. Which statements regarding factors that contribute to the severity of asthma are **false**? (*circle all that apply*)
   a) Dust mite exposure is ubiquitous, but routine use of pesticides to control dust mites is not useful in the management of moderate persistent or more severe asthma.
   b) Routine skin testing is not useful in the management of moderate persistant or more severe asthma.
   c) Cockroach exposure and sensitivity are frequently found in inner-city patients with moderate persistant or more severe asthma.
   d) Controlled studies of immunotherapy have demonstrated a reduction in symptoms from moderate persistent or more severe asthma.
2. Which of the following is **false** regarding the use of short-acting inhaled β_2-agonists?
   a) They are the most effective medication for relieving acute bronchospasm.
   b) Use of more than one canister per month indicates inadequate disease control.
   c) They should be used in a scheduled manner to reduce frequency of attacks.
   d) Frequent use can lead to decreased numbers of β_2-receptors in the lungs.
3. Which of the following is **not recommended** to modify indoor allergens in the homes of asthmatic patients?
   a) Frequent vacuuming
   b) Use of a humidifier
   c) Use of impermeable mattresses and pillows
   d) Air-conditioning during warm weather
4. Which of the following **is** recommended for most patients presenting with an acute asthma exacerbation?
   a) Methylxanthines (aminophylline or theophylline)
   b) Oral corticosteroids
   c) Systemic antibiotics
   d) Chest physiotherapy
   e) Anxiolytics
5. Which of the following statements regarding the use of inhaled corticosteroids is **false**?
   a) They decrease the overall severity of symptoms.
   b) They prevent airway remodeling.
   c) They act as a direct bronchodilator.
   d) They are associated with systemic steroid effects.
   e) They are associated with an increase in peak expiratory flow.
6. Which of the following is **not** an inhaled steroid?
   a) Beclomethasone dipropionate (Vanceril)
   b) Flunisolide (Aerobid)
   c) Salmeterol xinafoate (Serevent)
   d) Fluticasone propionate (Flovent)
7. Which of the following have **not** been shown to be associated with inhaled corticosteroids?
   a) Cataracts
   b) Adrenal suppression
   c) Glucose intolerance
   d) Bone demineralization

The National Asthma Education and Prevention Program, Guidelines for the Diagnosis and Management of Asthma classifies disease severity into four groups: Mild Intermittent, Mild Persistent, Moderate Persistent, and Severe Persistent. The next four questions ask you to classify patients into these categories.

8. A 38 yo male nonsmoker, with an FEV_1 of 85% predicted, uses β_2-agonists daily for symptoms, and has no nocturnal symptoms. This patient would be classified as:
   a) Mild Intermittent
   b) Mild Persistent
   c) Moderate Persistent
   d) Severe Persistent
9. A 46 yo smoker, with an FEV_1 of 80% predicted, has symptoms twice a week which require β_2-agonists and often require her to stop her activities, and has nocturnal symptoms 3–4 times a month. This patient would be classified as:
   a) Mild Intermittent
   b) Mild Persistent
   c) Moderate Persistent
   d) Severe Persistent
10. A 54 yo smoker, with an FEV_1 of 80% predicted, has symptoms only while running but never at rest. He was hospitalized for an exacerbation last year requiring nebulized β_2-agonists and a steroid burst and taper. This patient would be classified as:
    a) Mild Intermittent
    b) Mild Persistent
    c) Moderate Persistent
    d) Severe Persistent
11. A 36 yo non-smoker, with an FEV_1 of 65% predicted, has symptoms requiring β_2-agonists 3–4 times a week and rare nocturnal symptoms. This patient would be classified as:
    a) Mild Intermittent
    b) Mild Persistent

c) Moderate Persistent
d) Severe Persistent

12. Which of the following statements regarding spirometry is **false**?
a) Patients with mild intermittent asthma should have yearly spirometry even when they are asymptomatic
b) Spirometry data is more dependable than peak flow data, therefore spirometry should be repeated every one to two years in most patients
c) Spirometry testing should be done after treatment changes to assess efficacy of the treatment
d) Spirometry is useful to assess the accuracy of home peak flow meters
e) Spirometry is more useful than peak flow meters in detecting disease variability

13. Which of the following techniques for using inhalers is **unacceptable**?
a) Holding the inhaler 1 inch away from the lips
b) Using a brisk, quick inspiration
c) Holding the breath for ten seconds
d) Allowing one minute to pass between puffs

14. Which of the following **best** correlates with bronchial hyperresponsiveness?
a) Peripheral eosinophilia
b) History of atopy
c) Response to inhaled ipratropium bromide
d) Airway inflammation

15. Which of the following treatments is **not** recommended for most patients presenting with an acute asthma exacerbation?
a) Repetitive or continuous nebulized short-acting β-agonists
b) Supplemental oxygen to maintain $Sa_{O_2} > 90\%$
c) Mucolytic agents
d) Anticholinergic agents

16. Which of the following is **not** a direct cause of airway obstruction in asthma?
a) Eosinophilia
b) Acute bronchoconstriction
c) Airway edema
d) Chronic mucous plugs
e) Fibrotic airway remodeling

17. Which of the following is **false** regarding the use of long-acting inhaled β_2-agonists?
a) They are especially useful for prevention of nocturnal symptoms.
b) They should not be used for relief from an acute exacerbation.
c) Their use can help many asthmatics discontinue steroids.
d) They have been shown to result in significant increases in quality of life.

18. Which of the following medications is **least indicated** for long term control of asthma?
a) inhaled corticosteroids
b) long-acting inhaled β_2-agonists
c) inhaled anticholinergic agents
d) sustained-release methylxanthines

19. For asthma patients without symptoms between attacks, which of the following statements regarding the long term management is **not** correct?
a) They generally do not require daily medications.
b) Short-acting inhaled β_2-agonists as needed are usually sufficient.
c) Using short-acting β_2-agonists more than twice a week suggests they may benefit from long-term control medications.
d) They generally do not need to undergo periodic spirometry.

20. Which of the following data sets suggests an asthmatic patient at greatest risk of imminent respiratory failure?

	Pulse	Respirations	Blood pressure	Blood gas ($pH/P_{CO_2}/P_{O_2}$)
a)	120	28	140/90	7.49/25/56
b)	120	26	140/90	7.55/28/100
c)	120	28	110/65	7.39/42/56

21. Which of the following does **not** have anti-inflammatory properties?
a) Zafirlukast (Accolate)
b) Ipratropium bromide (Atrovent)
c) Nedocromil sodium (Tilade)
d) Triamcinalone acetonide (Azmacort)

22. Which of the following statements regarding long term control of asthma is **false**?
a) Due to side effects, inhaled corticosteroids should not be used until a patient has failed other modalities.
b) The most effective medications are aimed at decreasing inflammation rather than achieving bronchodilation.
c) High-dose therapy is used initially, then tapered to the smallest effective dose regimen.
d) Inhaled corticosteroids can normalize lung function and may prevent irreversible lung injury.

23. Patients with asthma may develop irreversible airflow obstruction because of:
a) fibrotic airway remodeling
b) down-regulation of β_2-adrenergic receptors
c) progressive loss of lung parenchyma
d) asthma doesn't develop irreversible airflow obstruction

24. Which of the following data sets is most suggestive of asthma as a primary diagnosis? (*Each value is % predicted*)

	$D_{L_{CO}}$	FEV_1	FVC	FEV_1 postbrochodilator
a)	50%	35%	70%	37%
b)	80%	85%	100%	91%
c)	50%	55%	50%	55%
d)	105%	70%	90%	85%
e)	70%	70%	90%	85%

25. Which of the following is **not** consistent with Mild Persistent asthma?
a) Daily short-acting inhaled β_2-agonist use
b) Peak expiratory flow variability 20–30%
a) Nocturnal symptoms once a week
b) $FEV_1 \geq 80\%$ predicted

26. All of the following have been documented with patient education in the management of asthma **except**:
a) Improved inhaler technique
b) Better quality of life
c) Increased forced expiratory volume in one second (increased FEV_1)
d) Less utilization of emergency resources
e) The benefits of patient education without reinforcement do not last longer than one year

27. For a patient with Moderate Persistent asthma who is inadequately controlled on daily low dose inhaled steroids, which of the following regimens is **not** appropriate?
a) Change to medium-high potency inhaled steroids
b) Add long-acting inhaled β_2-agonist
c) Add scheduled short-acting inhaled β_2-agonist
d) Increase inhaled steroid dose and add nedocromil

28. Which of the following are **necessary** to diagnose asthma?
a) Reduced forced expiratory volume in one second (FEV_1)
b) Reduced forced vital capacity (FVC)
c) Reversibility of airflow obstruction
d) Decreased diffusion capacity
e) Increased diffusion capacity

29. Which of the following is **not** a risk factor for death in an adult patient with asthma?
a) Use of 2 canisters per month of an inhaled β_2-agonist
b) Low socioeconomic status
c) Recent use of systemic steroids
d) History of childhood asthma
e) Three emergency care visits in the last year

30. Which of the following is **not** suggestive of asthma?
a) Wheezing

b) Stridor
c) Cough which is worse at night
d) Recurrent chest tightness

31. At which disease severity should anti-inflammatory medications be initiated?
a) Mild intermittent asthma
b) Mild persistent asthma
c) Moderate persistent asthma
d) Severe persistent asthma

The best answers considered in the analysis were: 1-d; 2-c; 3-b; 4-b; 5-c; 6-c; 7-c; 8-c; 9-b; 10-a; 11-c; 12-e; 13-b; 14-d; 15-c; 16-a; 17-c; 18-c; 19-d; 20-c; 21-b; 22-a; 23-a; 24-d; 25-a; 26-c; 27-c; 28-c; 29-d; 30-b; 31-b.